Interstellar Precursor Probe

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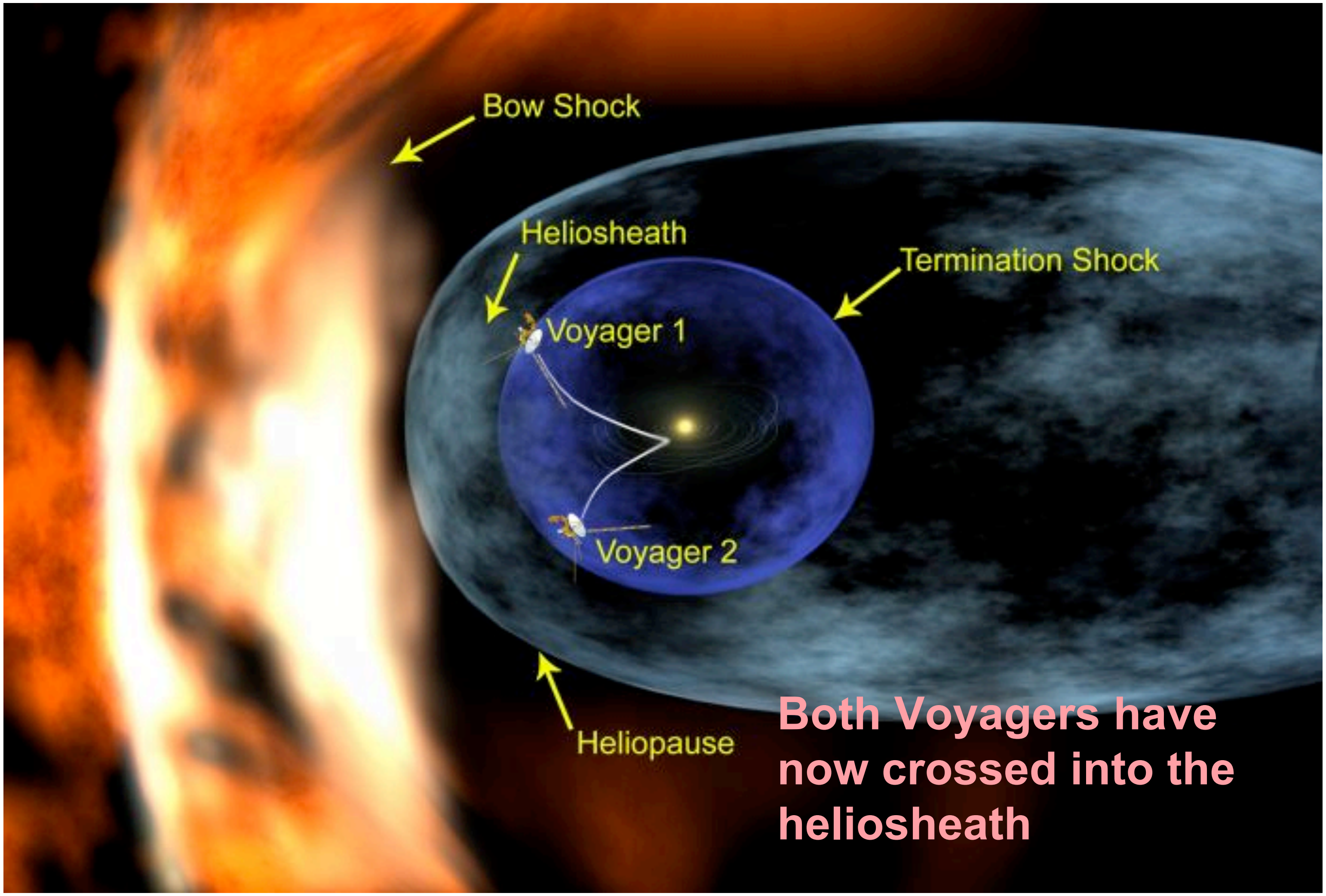
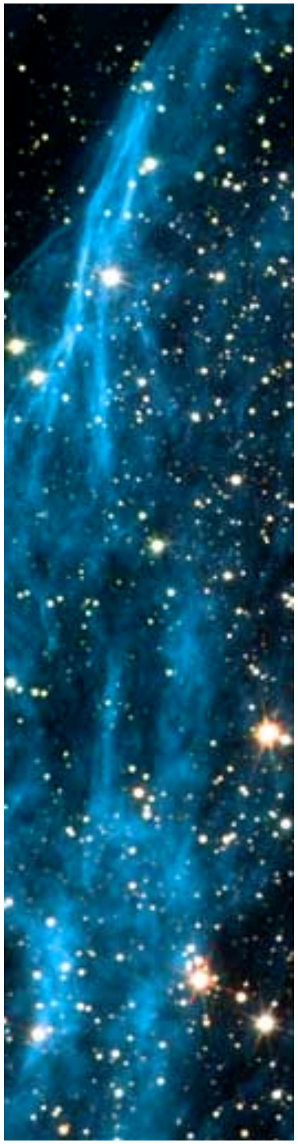
An Interstellar Probe Has Been Advocated for Over 30 Years

NASA Studies	National Academy Studies
Outlook for Space, 1976	Physics through the 1990's - Panel on Gravitation, Cosmology, and Cosmic Rays (D. T. Wilkinson, chair), 1986 NRC report
An implementation plan for solar system space physics, S. M. Krimigis, chair, 1985	Solar and Space Physics Task Group Report (F. Scarf, chair),1988 NRC study Space Science in the 21st Century - Imperatives for the Decade 1995-2015
Space Physics Strategy-Implementation Study: The NASA Space Physics Program for 1995-2010	Astronomy and Astrophysics Task Group Report (B. Burke, chair), 1988 NRC study Space Science in the 21st Century - Imperatives for the Decade 1995-2015
Sun-Earth Connection Technology Roadmap, 1997	The Decade of Discovery in Astronomy and Astrophysics (John N. Bahcall, chair)
Space Science Strategic Plan, The Space Science Enterprise, 2000	The Committee on Cosmic Ray Physics of the NRC Board on Physics and Astronomy (T. K. Gaisser, chair), 1995 report Opportunities in Cosmic Ray Physics
Sun-Earth Connection Roadmaps, 1997, 2000, 2003	A Science Strategy for Space Physics, Space Studies Board, NRC, National Academy Press, 1995 (M. Negebauer, chair)
NASA 2003 Strategic Plan	The Sun to the Earth - and Beyond: A Decadal Research Strategy in Solar and Space Physics, 2003
The New Science of the Sun - Solar System: Recommended Roadmap for Science and Technology 2005 - 2035, 2006	Exploration of the Outer Heliosphere and the Local Interstellar Medium, 2004
	Priorities in Space Science Enabled by Nuclear Power and Propulsion, 2006

Artist's Concept of Heliosphere and Trajectories of the Voyagers





The Science Questions

What is the nature of the nearby interstellar medium?
How do the Sun and galaxy affect the dynamics of the heliosphere?
What is the structure of the heliosphere?
How did matter in the solar system and interstellar medium originate and evolve?

Science Traceability and Strawman Instruments Have Been Mapped Out

- **Low-mass payloads focus on “fields and particles”**
  - ***In situ* measurements**
  - **Remote measurements (UV and neutral atoms) that use the unique vantage offered**
- **Cases for infrared absorption measurements are more problematic**
  - **Mass of optics and cooling apparartus**
  - **Large data rates**
- **Mass and power are significantly constrained**
  - **Goal has been tp remain at less that ~45 kg and 40 W, including ~30% margin for 10 instruments**
  - **Similar constraints on Pioneer 10: 11 instruments, 33 kg, 24 W**

Science Traceability Matrix

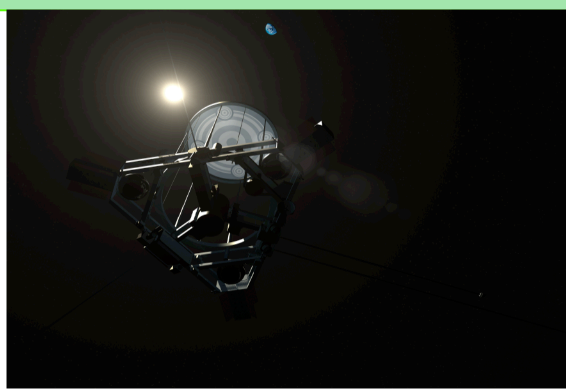
Science Questions	Interstellar Probe Science Objectives	Objective Questions	Science Measurement Objectives	Required Instruments	Analysis Product	Science Result
3rd Interstellar Probe Science and Technology Definition Team Mtg, 17-19 May 1999, JPL	From NASA's Interstellar Probe Science and Technology Definition Team Report		THIS WORK	THIS WORK	THIS WORK	
What is the nature of the nearby interstellar medium?	Explore the interstellar medium and determine directly the properties of the interstellar gas, the interstellar magnetic field, low-energy cosmic rays, and interstellar dust	How does the composition of interstellar matter differ from that of the solar system?	Elemental and isotopic abundances of significant species	PLS, EPS, CRS	Interstellar medium composition	**Composition differential between the solar system and current local interstellar medium**
		What constraints do the interstellar abundances of ^{2}H and ^{3}He place on Big Bang and chemical evolution theories?	^{2}H, ^{3}He, and ^{4}He abundances in the interstellar medium	CRS - LoZCR		
		Is there evidence for recent nucleosynthesis in the interstellar medium?	Isotopic abundances of "light" elements	CRS		
		What is the density, temperature, and ionization state of the interstellar gas, and the strength and direction of the interstellar magnetic field?	Bulk plasma properties, composition, and ionization state and vector magnetic field in the interstellar medium	MAG, PLS	Thermodynamic and physical state of the very local interstellar medium (VLISM)	**Physical state of the VLISM**
		What processes control the ionization state, heating, and dynamics of the interstellar medium?	Charge state, electron properties, Ly-α flux, neutral component properties	PLS, LAD, NAI, ENA	Energy inputs in the VLISM	
		How much interstellar matter is in the form of dust and where did it originate?	Dust flux, composition, pickup ion composition (from sputtering)	CDS, (PWS), PLS	Neutral matter assay for the VLISM	
		How much greater are cosmic ray nuclei and electron intensities outside the heliosphere, and what is their relation to galactic gamma ray and radio emission?	Cosmic ray ion and electron energy spectra; low frequency radio emissions	CRS, PWS	Low-energy galactic cosmic rays	
		What spectrum of 10-100 micron galactic infrared and Cosmic Infrared Background Radiation is hidden by emission from the zodiacal dust?	Infrared spectral measurements from 10 to 100 microns	Not measured	IR absorption by solar system dust	
How do the Sun and galaxy affect the dynamics of the heliosphere?	Explore the influence of the interstellar medium on the Solar System, its dynamics, and its evolution	What is the size and structure of the heliosphere?	Detect heliospheric boundaries from their plasma, field, and radio signatures	MAG, PWS, PLS, EPS, LAD, ENA	Heliospheric spatial scales	**Structure and dynamics of the heliosphere in the upwind direction**
		How do the termination shock and heliopause respond to solar variations and interstellar pressure?	*In situ* plasma and field measurements on the time scale of a fraction of a solar rotation (~days)	MAG, PLS	Heliospheric temporal variably	
		How does the interstellar medium affect the inner heliosphere and solar wind dynamics?	Pickup ions and anomalous cosmic rays, high energy electrons within the heliosphere	PLS, EPS, CRS	Spatial and temporal variability of the interstellar medium properties	**Effects of the VLISM on the heliosphere**
		What roles do thermal plasma, pickup ions, waves, and anomalous cosmic rays play in determining the structure of the termination shock?	Thermal plasma, pickup ions, wave, and anomalous cosmic rays properties on the scale of the scale of c/w_{pi}	PLS, EPS, PWS, CRS - AGCR	Inputs from heliospheric interaction into the solar wind	
		What are the properties of interstellar gas and dust that penetrate into the heliosphere?	Thermodynamic properties and composition of neutral gas; dust flux and composition	NAI, ENA, CDS	Properties of interstellar gas and dust in the outer heliosphere	
What is the structure of the heliosphere?	Explore the impact of the solar system on the interstellar medium as an example of the interaction of a stellar system with its environment	Does the heliosphere create a bow shock in the interstellar medium?	Plasma and magnetic field measurements at ion-inertial scale length from the heliosheath into the interstellar medium (telemeter changes)	MAG, PWS, PLS	Determination of whether the solar system produces an external shock	**Impact of the solar system on the local composition and thermodynamic properties of the VLISM**
		What is the relation of the hydrogen wall outside the heliopause to similar structures and winds observed in neighboring systems?	Neutral atom and plasma ion distribution functions from the heliopause through the heliosheath	NAI, ENA, PLS	Structure and properties of the predicted hydrogen wall	
		How do the Sun and heliosphere influence the temperature, ionization state, and energetic particle environment of the local interstellar medium? How far does the influence extend?	Particle properties from thermal plasma to galactic cosmic rays from inside the heliosphere at regular intervals though the heliospheric structure and into the interstellar medium	NAI, ENA, PLS, EPS, CRS	Penetration of heliosheath properties into the VLISM	
		How does particle acceleration occur at the termination shock and at other astrophysical shocks?	Ion and electron measurements from thermal plasma to low-energy cosmic rays on scales small compared with the shock passage time by the spacecraft	PLS, EPS, CRS - Autonomous burst mode for instruments as appropriate	Characterization of particle acceleration at the termination shock	
How did matter in the solar system and interstellar medium originate and evolve?	Explore the outer Solar System in search of clues to its origin, and to the nature of other planetary systems	Is there structure in the Zodiacal cloud due to dynamical processes associated with solar activity, planets, asteroids, comets, and Kuiper Belt objects?	Plasma and dust measurements on time scales of the solar rotation period	PLS, CDS, (PWS)	Structure and dynamics of the Zodiacal dust cloud in the outer heliosphere	**Properties and dynamics of bulk matter in the outer solar system and VLISM**
		What does the distribution of small Kuiper Belt objects and dust tell us about the formation of the solar system?	Dust and pickup ion spatial distribution and composition and composition variation with distance from the Sun	CDS, PLS, EPS, (PWS)		
		How does the structure of the Zodiacal dust cloud impact infrared observations of the galaxy and searches for planets around other stars?	Infrared flux from near IR to at least ten's of microns	Not measured	Quantified extinction from Zodiacal dust	
		What are the origin, nature, and distribution of organic matter in the outer solar system and the interstellar medium?	Dust composition, pickup ions from C, N, O	CDS, PLS, EPS, (PWS)	Identification of *in situ* organic materials or fragments in the heliospheric boundary regions and/or VLISM	

Interstellar Probe Instrument Resources and Requirements

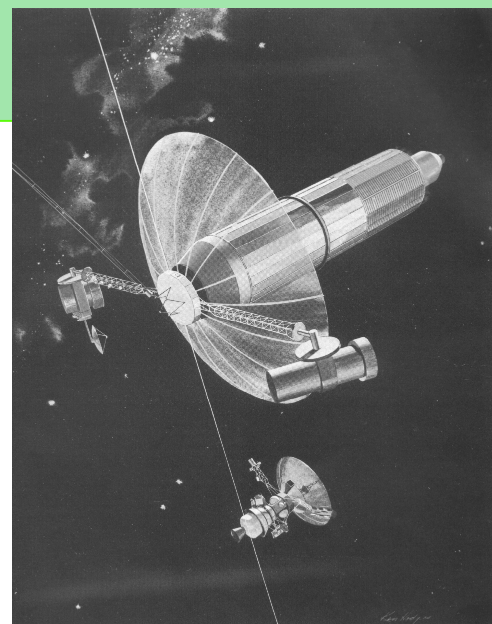
THIS WORK	IIE Team Consensus Payload							Mission and Spacecraft Requirements	Data Product
Material Measured	Acronym	Instrument	Mass (kg)	Power (W)	Acquisition data rate (bps)	Capabilities	Implementation	THIS WORK	THIS WORK
Fields	MAG	Magnetometer	8.81	5.30	130.00	2- three-axis fluxgate magnetometers; do one sample per day from each magnetometer (onboard processing from multiple samples per spacecraft roll period which is	65 bits/sample x number of samples per day x number of sensors; inboard and outboard fluxgate magnetometers mounted on 5.1 m, self-deployed	Magnetically clean spacecraft	**B**-field vectors
	PWS	Plasma wave sensor	10.00	1.60	65.00	Three 20-m self-supported antennas; measure E-field vectros up to 5 kHz; no search coils (no B-field components)	From Voyager: 115,000 kbps -> 12.5 kilosamples per second with a 14 bit A/D. Collect 2048 samples and do onboard FFT- frequency of processing limited by	Antenna at least ~20m length	**E**-field power spectra
Plasma and suprathermal particles	PLS	Plasma	2.00	2.30	10.00	Plasma ions and electrons from the solar wind, interstellar wind, and interaction region; thermal, suprathermal, and pickup component properties and composition	Mount perpendicular to spin axis; need clear FOV for a wedge 360° around by ~±30°	Clear FOV in direction to Sun, clear FOV in direction anti-Sun; equipotential spacecraft	Ion and electron distribution function; composition
Solar energetic particles through galactic cosmic rays	EPS	Energetic particle spectrometer	1.50	2.50	10.00	TOF plus energy measurements give composition and energy spectra; ~20 keV/nuc to ~5 MeV total energy for ions in 6 pixels; electrons ~25 keV to ~800 keV	Mount perpendicular to spacecraft spin axis; clear FOV of 160° x 12° wedge; on-board processing with magnetometer output to get pitch-angle distributions fordownlink	Clear FOV	Ion and electron pitch angledistributions functions; composition
	CRS - ACR/GCR	Cosmic-ray spectrometer: anomalous and galactic cosmic rays	3.50	2.50	5.00	Energy Range on ACR end (stopping particles) H, He: 1 to 15 MeV/nuc Oxygen: ~2 to 130 MeV/nuc Fe: ~2 to 260 MeV/nuc Energy Range on GCR end Electrons: ~0.5 to ~15 MeV P, He: 10 to 100 MeV/nuc stopping 100 - 500 MeV/nuc penetrating Oxygen	Measure ACRs and GCRs with 1 > Z > 30: double-ended telescope with one end optimized for ACRs and the other for GCRs. It would also measure penetrating particles as is done on Voyager so that both ends need to have clear FOVs. GCR end FOV = 35° ACR en	Clear FOV	Differential flux spectra by composition
	CRS - LoZCR	Cosmic-ray spectrometer: electrons/positrons, protons, helium	2.30	2.00	3.00	Energy Range: positrons: 0.1 to 3 MeV electrons: 0.1 to 30 MeV gamma-rays: 0.1 to 5 MeV H: 4 to 130 MeV/nuc He: 4 to 260 MeV/nuc	FOV = 46° full cone Geometry Factor = 2.5 cm2sr Measurement technique DE X E (e-, H, He) annihilation (e+) Dröge, W., B. Neber, M. S. Potgieter, G. P. Zank, and R. A. Mewaldt, A cosmic ray dectector for an interstellr probe, pp. 471-474, in "The Outer H	Clear FOV	Differential flux spectra
Neutral material	CDS	Cosmic dust sensor	1.75	5.00	0.05	Same capabilities as the student dust counter (SDC) on New Horizons	Mount within 5° of ram direction; sesnor area/FOV of 30 cm x 50 cm must not be obscurred	Clear FOV in ram direction	Dust particle mass and limited composition
	NAI	Neutral atom detector	2.50	4.00	1.00	Measure neutral H and O at >10 eV/nucleon incoming from interstellar medium [10 eV/nuc ~44 km/s; incoming neutrals are at ~25 km/s with respect to the	Single pixel; mount looking into ram direction; conversion-plate technology	Clear FOV in anti-Sun (ram) direction	Neutral distribution functions
	ENA	Energetic neutral atom imager	2.50	4.00	1.00	Views 0.2 to 10 keV neutral atoms, 1 pixel;	~6° x 6° FOV, mount with sensor looking perpendicular to spacecraft spin axis	1-axis scanner perpendicular to spin axis	Energetic neutral atom energy flux
Photons	LAD	Lyman-alpha detector	0.30	0.20	1.00	Single-channel/single-pixel photometer (at 121.6 nm) similar to those on Pioneer 10/11 (but without the 58.4 nm channel)	Mount perpendicular to nominal spin axis; need clear field of view (~4° x 4°); average over azimuthal scan provided by spacecraft motion	1-axis scanner perpendicular to spin axis	Lyman alpha flux
			35.16	**29.40**	**226.05**				

All Approaches to an Interstellar Probe Mission Need Propulsion Development

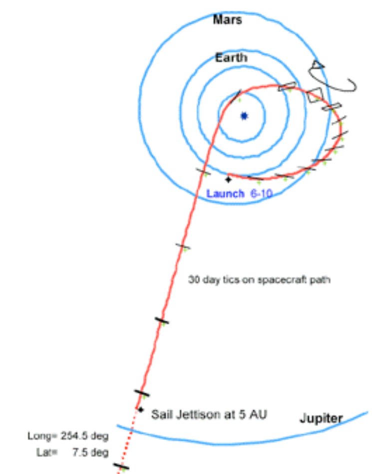
- Ballistic (NIAC 2004)
  - optimized launch 20 Feb 2019
  - Jupiter flyby 19 June 2020
  - Perihelion maneuver 4 Nov 2021 at 4 RS
  - 1000 AU 17 Oct 2071
  - 12.16 kg science
  - 1.1 MT

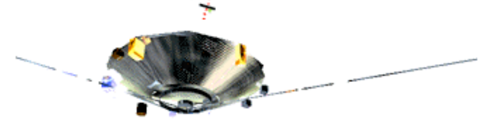


- Nuclear Electric (JPL 1980)
  - 2015 departure 20 years to 200 AU
  - 30 kg science package
  - Bimodal nuclear propulsion
  - 11.4 MT



- Solar Sail (NASA 1999)
  - 200 AU in 15 years
  - Perihelion at 0.25 AU
  - Jettison 400m dia sail at ~5 AU
  - 25 kg science
  - 246 kg





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APL Space Department

Top-Level Mission Requirements for the Radioisotope Electric Propulsion (REP) NASA Vision Mission

- **Launch spacecraft to have an asymptotic trajectory within a 20° cone of the "heliospheric nose" (+7°, 252° Earth ecliptic coordinates)**
- **Provide data from 10 AU to 200 AU**
- **Arrive at 200 AU "as fast as possible"**
- **Consider all possible missions that launch between 2010 and 2050**
- **Use existing launch hardware** **Relax for use of Ares V**
- **No "in-space"assembly**
- **Launch to escape velocity**
- **Keep new hardware and technology to a minimum**
- **Provide accepted "adequate" margins**

Propulsion "Contenders" Trade Technology Readiness Against Flight Time

- Radioisotope Electric Propulsion (REP)
  - Near-term technology
  - High-efficiency, low-specific mass radioisotope power supplies (RPS)
  - Work from 1 AU outward
- Solar Sail
  - Needs low areal mass density (~1 g m^{-2} or less)
  - Needs to deal with high temperature
  - Work from ~0.25 AU outward
  - Current technology RPS sufficient for power

REP Implementation

TEAM X
Jet Propulsion Laboratory

ADVANCED PROJECTS DESIGN TEAM
INTERSTELLAR EXPLORER VISION MISSION
CUSTOMER: RALPH MCNUTT
REPORT ID #794
LEADER: CHARLES BUDNEY
5, 7, 8 APRIL 2005

The following representatives comprised the study team:

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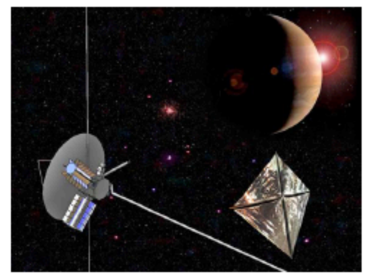
Solar Sail Implementation

esa

INTERSTELLAR HELIOPAUSE PROBE

STUDY OVERVIEW OF THE INTERSTELLAR HELIOPAUSE PROBE



AN ESA TECHNOLOGY REFERENCE STUDY

Planetary Exploration Studies Section (SCI-AP)
Science Payload and Advanced Concepts Office (SCI-A)

prepared by/préparé par	A.E. Lyngvi, M.L. van den Berg, P. Falkner
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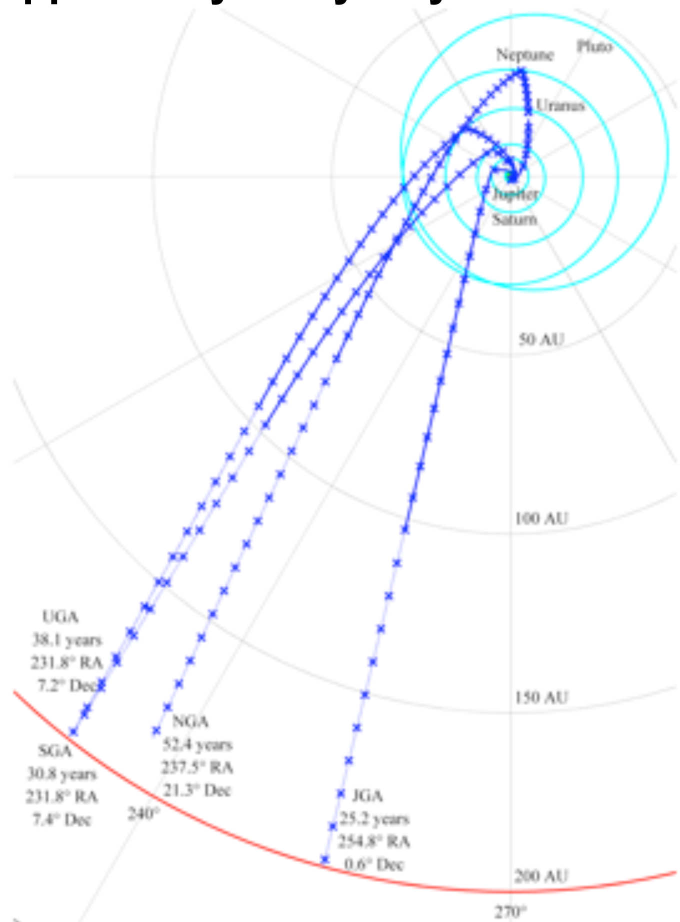
"Vision Mission" REP Mission Design Options

- Various upper stage options for Delta IV H were studied
- Investigated 12 existing and conceptual upper stages
- Final system was too heavy for Star 48 + Star 37 upper "stage"
- Went to a Star 48A "double stack" with custom interfaces

Baselined single Jupiter flyby - prime opportunity every 12 years



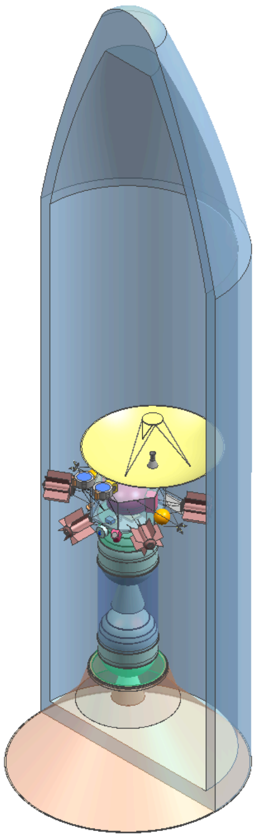
Four REP S/C Options Studied

1 - 5.8 kbps (200 AU) = 500 bps accumulation 24/7
- 586.1 kg dry/761.9 kg with contingency/1283.3 kg wet
- Three 1000 W ion engines, 2.1-m HGA, 4 CDS strings

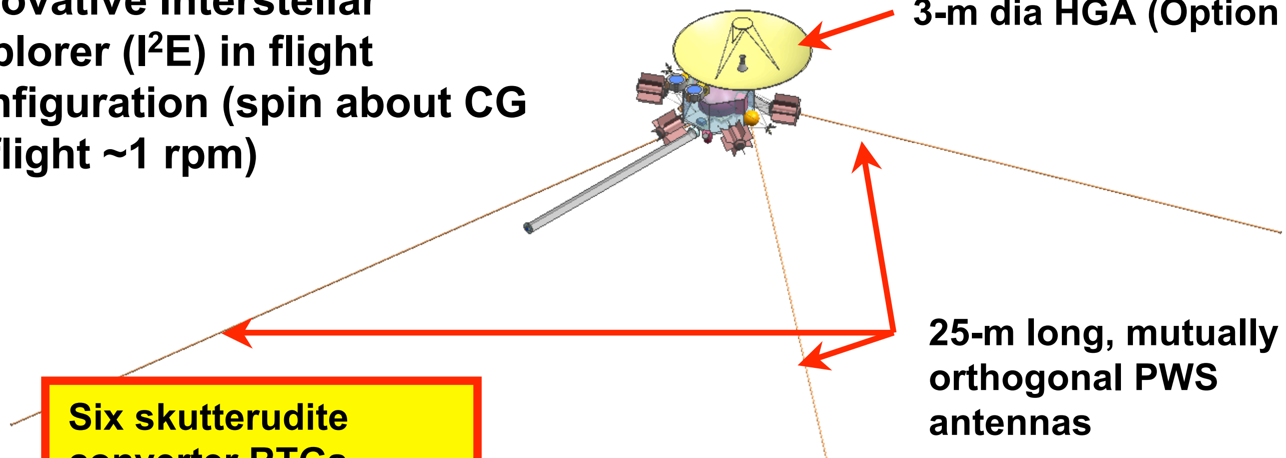
2 - same as 1 with aggressive technology
- 518.5 kg dry/674.0 kg with contingency/1191.4 kg wet
- Two 1000 W ion engines, 3-m HGA, 2 CDS strings

3 - 500 bps (200 AU); baseline with reduced data rate
- 571.4 kg dry/742.8 kg with contingency/1262.8 kg wet
- Three 1000 W ion engines, 2.1-m HGA, 4 CDS strings

- 4 - Aggressive technology; 500 bps rate; low power
  - 465.3 kg dry/604.9 kg with contingency/1066.2 kg wet
  - Two 750 W ion engines, 2.1-m HGA, 2 CDS strings



Innovative Interstellar Explorer (I^2E) in flight configuration (spin about CG in flight ~1 rpm)

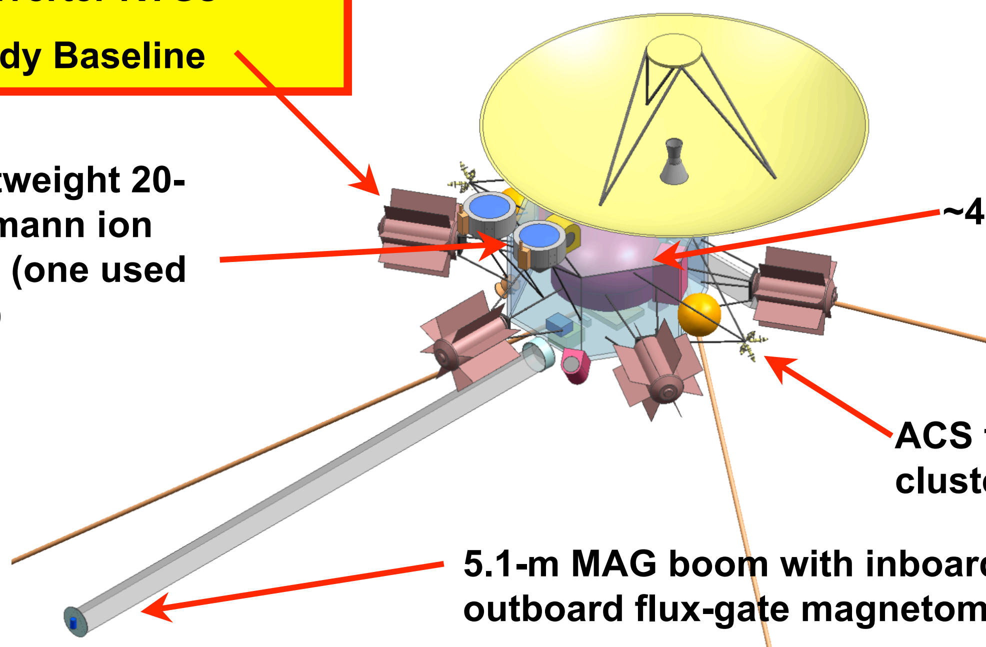


3-m dia HGA (Option 2)

25-m long, mutually orthogonal PWS antennas

Six skutterudite converter RTGs

Study Baseline



Two lightweight 20-cm Kaufmann ion thrusters (one used at a time)

~450-kg Xe tank

ACS thruster cluster (hydrazine)

5.1-m MAG boom with inboard and outboard flux-gate magnetometers

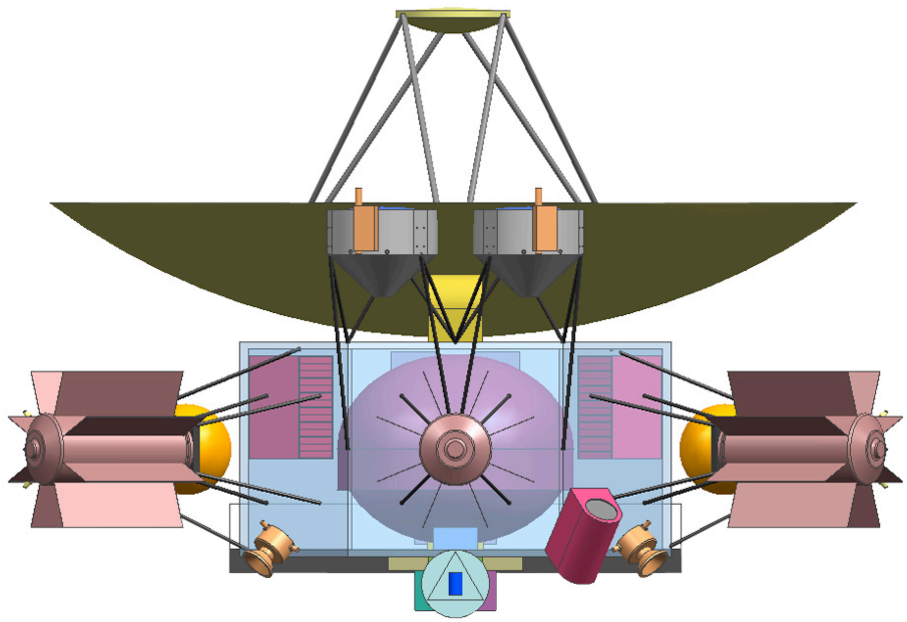
I^2E in Delta IV shroud with stacked Star 48As - launch configuration

Study Baseline

Constellation Architecture Use

- **The building blocks must exist now or following Ares flight certification**

Atlas V Centaur stage
1 or 2 engines
(2 is better)



IIE spacecraft
(REP)

Ares V

Assembling the Pieces

- Figure is to approximate scale
- Earth Departure Stage is only partially fueled to optimize launch energy
- First iteration: C_3~270 km²/s²
  - Corresponding asymptotic speed from the solar system is ~19.0 km/s ~ 4 AU/yr
  - New Horizons
    - Launched to 164 km²/s²
    - Pluto flyby at 13.8 km/s = 2.9 AU/yr
  - Voyager 1 current speed = 3.6 AU/yr
  - Voyager 2 current speed = 3.3 AU/yr
- To reach 9.5 AU/yr (45 km/s) with only a launch from Earth would require C_3 = 1,016 km²/s²
- Even with an Ares V, launch remains only one component

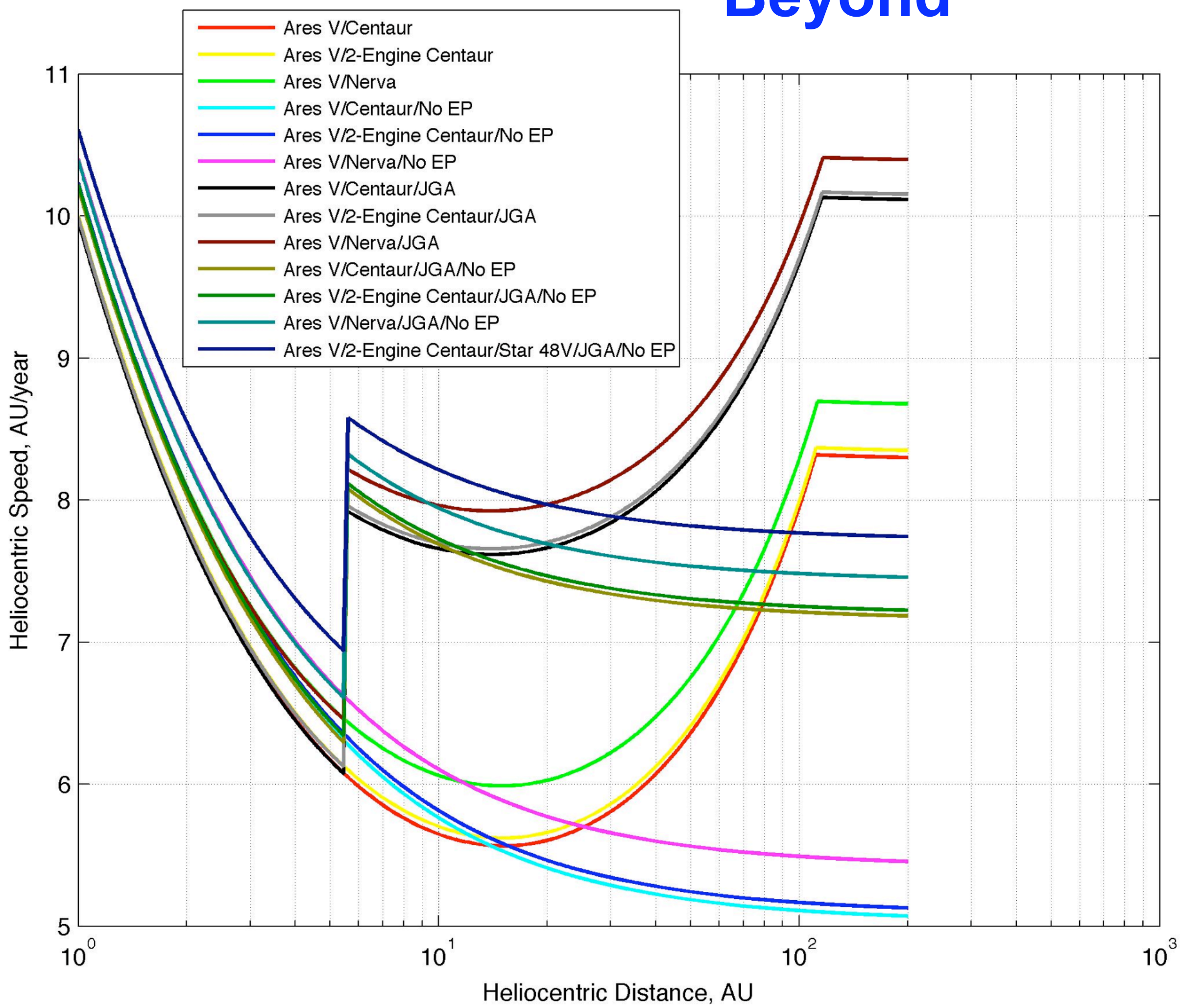
Earth orbital speed = 29.79 km/s; 1 AU/yr = 4.74 km/s

Nuclear Upper Stage

- Nuclear stage advantages
  - More performance than Centaur V1
  - Lower mass
  - Earth escape trajectory
  - Fully flight qualified
- Nuclear stage disadvantages
  - More expensive than Centaur
  - Larger (low LH2 volume)
  - Not solar system escape trajectory
  - Requires development
    - Gamma engine thrust 81 kN (18,209 lbf)
    - BNTR engine thrust 66.7 kN (15,000 lbf)
    - 3 BNTR's baselined for Mars DRM 4.0 of 1999
- Nuclear EDS not acceptable
  - Not Earth-escape trajectory
  - Comparable thrust engine to NERVA 2
    - 867.4 kN (195 klbf)
    - Stage mass: 178,321 kg wet, 34,019 kg dry
    - Compare S IVB: 119,900 kg wet, 13,300 kg dry; J-2: 486.2 kN (109.3 lbf)
  - No development plans or identified requirements

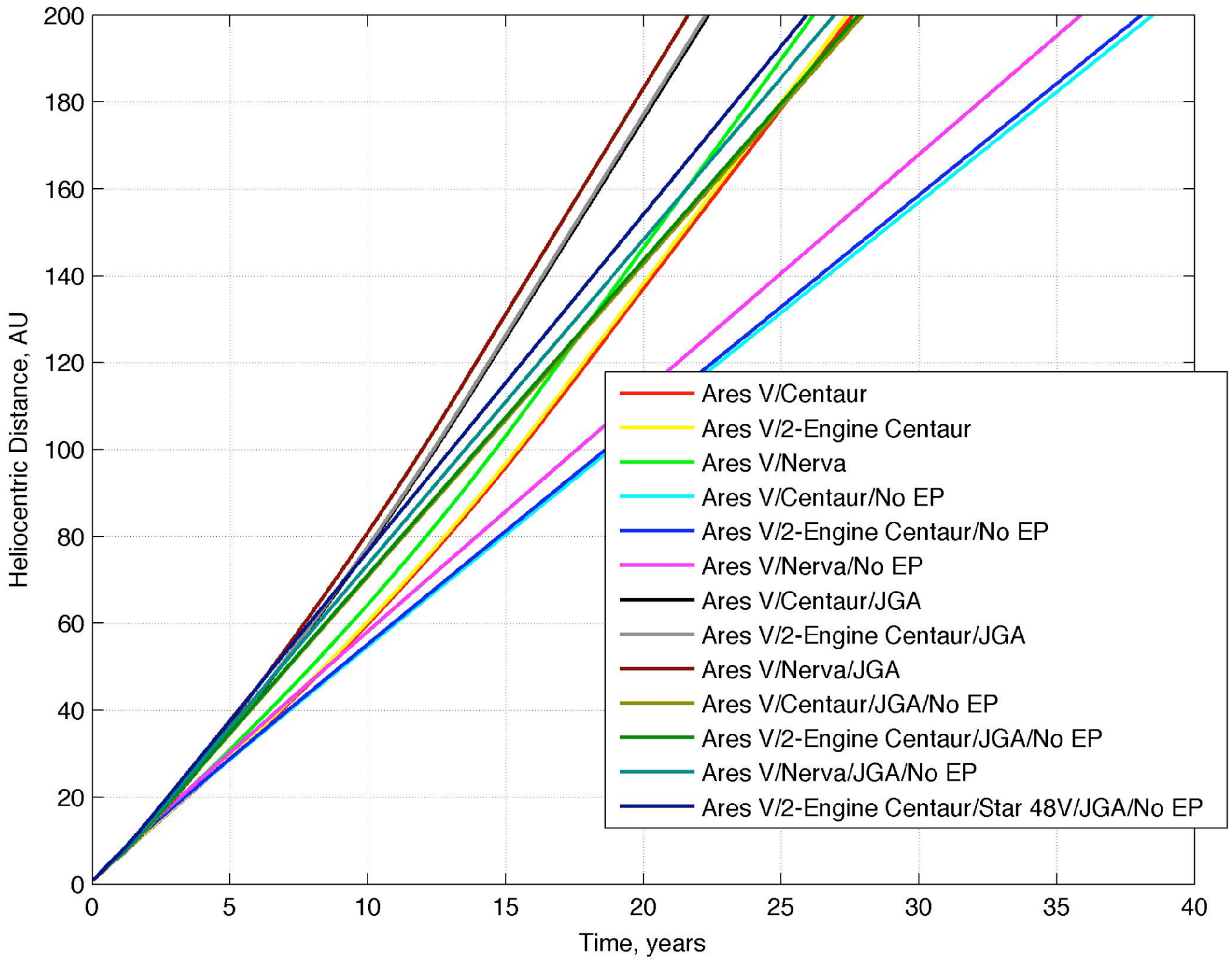
15 klbf BNTR engine

Comparing the Options: Speed to 200 AU and Beyond



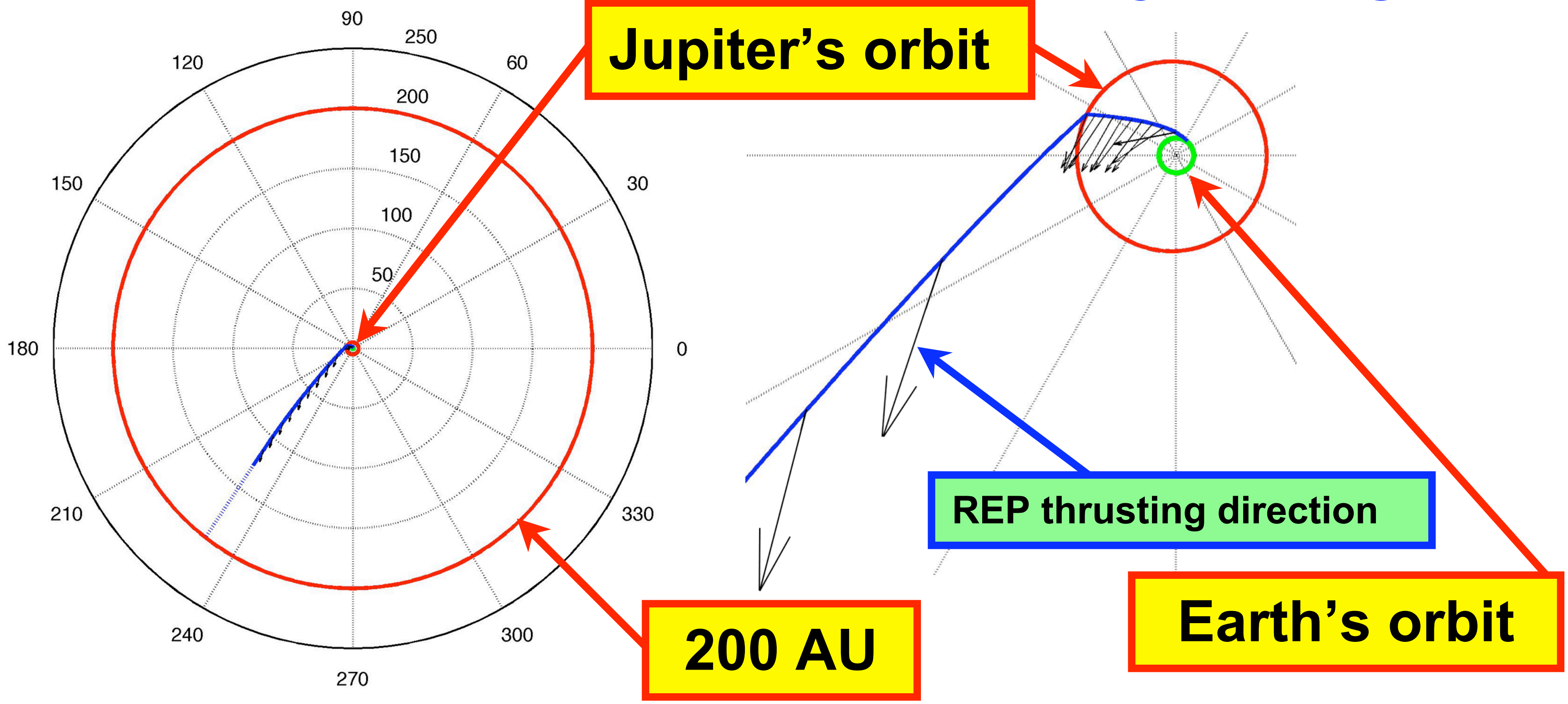
- **Probe speed versus heliocentric distance**
  - **To 200 AU**
  - **Log distance**
  - **JGA is the discontinuity**

Comparing the Options: Time to 200 AU



- **Spread among options is ~22 to 38 years to 200 AU**
- **Widens in going to even larger distances**
- **Initial goal had been 15 years to 200 AU**

Constellation-Enabled Trajectory



- As with previous analyses, it the the synergistic combination of 1) launch energy (C_3), 2) gravity assist at Jupiter (JGA), and 3) ion engines powered by a high-specific-energy radioisotope power source (REP) that makes the high flyout speed possible

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Schedule for Ares V Launch

(Option 1 - minimum new technology; Twin-engine Centaur)

- ✓ 2004-2005 Update of NASA strategic plan with ISP Vision Mission included
- ✗ 2006-2007 Focused technology development for small probe technologies
- ✗ 2007-2010 Focused technology development for an Interstellar Probe
- 2010 Start RPS fuel procurement and NEPA approvals
- 2010-2015 Design and launch I^{2}E probe (launch 1 year later)
- 2016 Begin routine data acquisition following Jupiter gravity assist

- 2020 Voyagers cease transmission at L + 43 years: V1 at ~150 AU, V2 at ~125 AU
- 2038 Data return from 200 AU [Mission Success]; Launch + 22.3 yrs (-7.9 yr)
- 2048 Data returned from 300 AU (at 10.2 AU/yr); L+32.1 yrs (-9 yr)
- 2116 Probe at 1000 AU - “Undisturbed” VLISM reached by now; 1.1 half-lives since original Pu-238 procurement; L + 100 yrs - but still have plenty of power to run spacecraft!

- **Ares V speeds up arrival to 1000 AU by 31 years**

Enablers for ANY Architecture

- **“Affordable” launch vehicle including high-energy stage**
- Delta IV H: ~$250M (http://www.astronautix.com/lvs/delheavy.htm) + Star 48A stage - guess ~$30M
- Ares V: unknown + Centaur stage: unknown
- **kWe power supply with low specific mass**
  - Six at (guess) $80M each ~$500M for REP; one or two for solar sail
- **Reliable and sensitive deep, space communications at Ka-band**
  - Aperture fee tool from http://deepspace.jpl.nasa.gov/advmiss/#discover
  - Real year 3 tracks / wk; 34-m HEF through 2032; switch to 70-m through 2044
  - $64M/yr on 70-m (used to estimate); total $930M
- **Mission operations and data analysis (MO&DA)**
  - $10 M per year for 30 years at 3% per annum inflation ~$500M

Si requiritis futurum nostrum, spectate astra!

Innovative Interstellar Probe 08/14/2008 06:48 PM

- HOME + OVERVIEW + SCIENCE + MISSION + SPACECRAFT + EDUCATION + GALLERY + LINKS

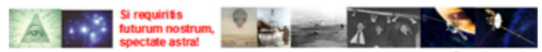
- HOME
+ BOUND FOR THE STARS
+ STUDY SUMMARY

Innovative Interstellar Explorer

Flight to the stars is the stuff of dreams – and of new scientific discoveries

The Innovative Interstellar Explorer is a NASA "Vision Mission" study funded by NASA following a proposal under NRA-03-OSS-01 on 11 September 2003. This study has focused on the elusive quest to reach and measure the interstellar medium, the "undiscovered country" outside of the influence of the nearest star, our Sun.

Distances in space are big, and so propulsion is always the driving technical element for missions to new places to do new things. Our innovation has been to seek a technical solution using radioisotope propulsion (REP): the use of electricity from known deep space power source technologies to run an ion engine to achieve a "reasonable" speed. Miniaturization and lightweight, high-efficiency power conversion are key to such an approach.



For credits see gallery

The vision of taking the first steps toward the stars has been one of the drivers and setters of paradigms throughout technical history. From the Montgolfiers' flight over Paris to that of the Wrights over Kitty Hawk, Goddard's first rocket to Explorer 1, and finally Pioneer 10 to the Voyagers, we keep reaching out. As history has shown time and again, to do otherwise is to slip toward decline and superstition.

Ours is a possible approach to continue in that quest.

Si requiritis futurum nostrum, spectate astra!
(If you seek our future, look to the stars!)

Time to opening of first launch window 12 Noon Eastern Daylight Time 22 October 2014

Time to Window Opening
22 October 2014, 16:00:00 UTC

DAYS	HRS	MINS	SECS
2259	17	21	37

Acknowledgments

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Time for a New Pioneer?